

OC3.1 Laser Transmitter/Receiver Systems for NASA Optical Communications Applications in Planetary Missions

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ABSTRACT

The costs and risks associated with launch of large spacecraft systems has caused NASA to stress the use of smaller micro and mini spacecraft missions for deep space. This has give rise to a large number of proposed Discovery-class missions that weigh only a few hundred kilograms and occupy only about one cubic meter. At the same time, many of the planets have already had the initial flyby missions and now more in-depth investigations producing larger volumes of data are desired. This "more for less" emphasis creates a need for advanced technology solutions that can accommodate the current fiscal and technical constraints. Laser communications is a technology that is ideally suited to such applications.

JPL has been developing technology and systems designs for this area for the past 14 years. Initially the work concentrated on systems applications studies but has now transitioned into a multi-faceted program covering spacecraft technology development, Earth-reception-end systems definition, and a set of systems-level technology experiments.

The centerpiece of the spacecraft technology development is a program called the Optical Communications Demonstrator (OCD). The OCD program is developing a laboratory-qualified, but form, fit and function equivalent of a spacecraft optical communications terminal. The terminal has a 10 cm diameter telescope aperture, a fiber optic-coupled laser transmitter assembly, and accomplishes all required spatial acquisition, tracking and point-ahead compensation with a single 2-axis steering mirror and a single 2-dimensional CCD detector array (see Fig. 1). The design is capable of a return data link of 100 Mbps from a low-Earth-orbit satellite, or can support 4 kbps data return from a microspacecraft at Pluto.

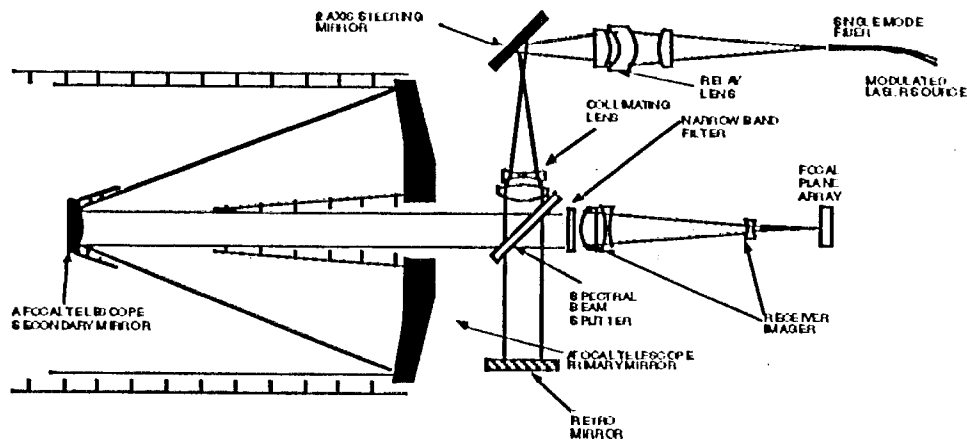


Figure 1 - Layout of the Optical Communications Demonstrator optical system

Supporting the spacecraft technology development is a set of systems design and performance prediction tasks for the Earth-reception systems. These systems include a set of three autonomous visibility monitoring observatories to gather statistics on atmospheric attenuation of optical signals, studies and systems designs to define a 10 meter diameter optical receiving station for ground-based reception, a reception network study to define the number and locations of stations for a ground-based optical reception network, and a pair of contractor-performed studies to define an orbiting optical reception station. These activities are further augmented by development and evaluation tasks for narrowband optical filter techniques that can eliminate most of the solar interference.

To validate the technology and to gain experience at the systems level, a number of experimental programs **have been initiated**. Last December a demonstration was conducted with the Galileo spacecraft wherein pulsed laser signals were transmitted from the ground to the spacecraft and detected by the spacecraft's imaging camera. **The GOPEX demonstration** demonstrated optical communications over spacecraft ranges from 600,000 km to 6,000,000 km. A second demonstration scheduled for late 1993 will transmit atmospherically compensated laser beams to the corner cube reflectors on the moon. The relative advantages of using artificial laser guidestar signals to remove the turbulence effects of the atmosphere will be evaluated.